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Determination of nutritional profile of Nakima (*Tupistra nutans*)

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Abstract
Nakima (*Tupistra nutans*) is one of the indigenous underutilized vegetable crops of the State of Sikkim and the inflorescence part is used for consumption. The study has been conducted at Dept. of Horticulture, Sikkim University, Gangtok during 2014-15 with an objective to determine the various dietary nutrients of Nakima (*Tupistra nutans*). The Nakima inflorescence were collected from all the four districts of Sikkim i.e. East, West, North and South. There were altogether eight samples i.e. two samples from each of the four districts of Sikkim. Three replications were taken for each sample and the statistical design used was Completely Randomized Design (CRD). The study includes determination of crude fat, crude fibre, ash, crude protein, reducing sugar, Vitamin C, major elements, minor elements and toxic elements of Nakima (*Tupistra nutans*). The multi elements determined in the study are being reported in separate publication. As the vegetable crop under study is liked by people of Sikkim, so the determination of full nutritional profile would indeed be helpful in increase in its production and marketing in and outside the State of Sikkim.

Keywords: Nakima, underutilized vegetable crop, nutritional profile

Introduction
Nakima (*Tupistra nutans*) belonging to the family Liliaceae is a vegetable with various species of flowering plants found in South Asia from South China to Sumatra Ambon Island. It is cultivated throughout Sikkim and is extensively cultivated in temperate climate. It is an unusual rhizome genotype from the eastern Himalayas with long strap like leaves up to 1-2 metre in length forming a tall lush clump of evergreen foliage resembling Aspidistra. Inflorescence is of attractive colour, shape, size and nice keeping quality. It is mostly found in the moist and shady place and available in local market during the month of September-October. Its inflorescence is used as curry spicy vegetable as well as for medicinal purposes also. Nakima plant is propagated through suckers.
The main importance of this work is to determine the nutritional value of this vegetable which is grown in Sikkim and is liked by local people also. The full nutritional profile of nakima has not been developed yet. By keeping in view, the above mentioned points the present study was undertaken with the objectives of analyzing various dietary nutrients present in the inflorescence of Nakima (*Tupistra nutans).*

Materials and methods
The present research work entitled "Determination of Nutritional Profile of Nakima (*Tupistra nutans*)" was carried out during the year 2013-2015 in the P.G Laboratory, Department of Horticulture, Sikkim University, 6th mile Samdur, Tadong, Gangtok at the altitude of 1610 m and with latitude and longitude as $N^0 27^0 18.495'$ and $E^0 88^0 35.307'$. The details of materials used and methodology employed during the course of investigation are being described as follows:

Instruments used
The instruments used in the research work were ICP-MS and micro-wave digestion, digital balance, crude fibre extractor, muffle furnace, hot air oven, Willey mill, exhaust fan, oil extractor, centrifuge, UV VIS spectrophotometer, mortar and pestle, hot plate, water bath and centrifuge were used.

Experimental material and sample collection

Nakima (*Tupistra nutans)* inflorescences were used as experimental material for the present study. Nakima (*Tupistra nutans*) inflorescences were used as experimental material in the present study and sample collection was done during October-November, 2014. The Sample 1 was collected from Naga village and Singik (North Sikkim) and Sample 2 was collected from Assamlingzey and Samsing (East Sikkim). Sample 3 was collected from Lower Perbing, Lower Chuba (South Sikkim) and Sample 4 was collected from Gairigaon and Martam (West Sikkim).

Fig 1: Nakima plant (*Tupistra nutans*)

Fig 2: Nakima inflorescence

Experimental methods

The present research was conducted in PG Laboratory, Department of Horticulture, Sikkim University, 6th mile Tadong, Samdur, Gangtok. The dietary nutrients were analyzed by following methods as given below:-

Extraction of crude fat

Crude fats was determined by essential oil extractor, model no Socsplus-SCS 06 DLS, Pelican. In this method ether extracted material in food was extracted from an oven-dried sample using Soxhlet extraction apparatus. The residue was weighed after evaporation of ether. In this method water soluble materials are not extracted since the sample was thoroughly dried prior to extraction with anhydrous ether or petroleum ether. The percentage of crude fat content of the sample is calculated by the following formula which gives the difference in the weights of the original flask and the flask plus extracted fat which represents the weight of the fat present in the original sample.

Hence, % of crude fat content of the sample = $(W_2 – W_1)$/ Wt. of sample × 100

Where, W1 = weight of the empty beaker (g)

W2 = weight of the beaker + fat (g)

Estimation of crude fibre

Crude fibre was analyzed using fibre estimation system, model no Fibra plus-FES 04 AS DLS, Pelican. Crude fibre is the organic residue which remains after the food samples have been digested under standardized conditions with 1.25% of sulphuric acid at 500 ^{0}C for 30 min and 1.25% of sodium hydroxide at 400 ^{0}C at 45 min. The crude fibre consists largely of cellulose with little lignin. As the recovery of cellulose using the specified procedure seldom exceeds four-fifths of that actually present, the crude fibre content does not represent a measure of a specific group of substances.

Crude fibre content of the sample was calculated out by using the following formula:

Hence, % of crude fibre content of the sample = $(W_2 – W_1)$/ Wt. of sample x 100

Where, W1 = weight of the sample + crucible before ashing (g)

W2 = weight of the sample after ashing (g)

Estimation of Ash content

According to this method, 2.5gm oven dried samples were weighted out in a crucible, this crucible was heated in muffle furnace at 600 ^{0}C for three hours, and then it was cooled in a desiccator, waited for completion of ash and then cooled. When the ash becomes white or greyish in colour, weight of the ash content is calculated out by using the following formula-

Ash % = (Weight of ash sample)/ (Weight of the sample taken) ×100

Estimation of crude protein

The crude protein was determined using Lawry's method as given by Thimmaiah (2004) [8] by UV/VIS Spectrophotometer, Perkin Elmer, Lambda 35 UV/VIS spectrometer. Protein reacts with the Folic-Ciocalteu reagent (FCR) to give a blue-coloured complex. The colour so formed is due to the reaction of the alkaline copper with the protein as in the biuret test and the reduction of phosphomolybdic-phosphotungstic compounds in the FCR by the amino acids tyrosine and tryptophan present in the protein. The intensity of the blue colour is measured calorimetrically at 660nm. The intensity of the colour depends on the amount of aromatic amino acids present and will thus vary for different proteins as reported by Thimmaiah (2004) [8].

Determination of vitamin C

Vitamin C (Ascorbic acid) content was determined by 2, 6-dichlorophenol-indophenol visual titration method as suggested by Ranganna (2012) [6]. Many fruits and vegetables are important sources of ascorbic acid. The most satisfactory chemical methods of estimation are based on the reduction of 2, 6-dichlorophenol indophenol by ascorbic acid and those on the reaction of dehydroascorbic acid with 2, 4-dinitrophenylhydrazine. The dye, which is blue in alkaline solution and red in acid solutions is reduced by ascorbic acid to a colourless form. The reaction is qualitative and practically specific for ascorbic acid in solution in the pH range of 1.0-3.5.

Formula: Dye factor = $\frac{0.5}{\text{Titre}}$

Vitamin C content of the sample was calculated by using the following formula:

mg of ascorbic acid per 100g or ml = $\frac{\text{Titre x Dye factor x Volume made up x 100}}{\text{Aliquot of extract x wt. or volume of sample taken for estimation taken for estimation}}$

Statistical analysis

The treatments were subjected to ANOVA using Completely Randomized Design (CRD). The numbers of samples (treatments) were eight for Nakima. The data were recorded for estimation of crude fat, crude fibre, ash content, crude protein, reducing sugar, Vitamin-C. Three replications were taken for all the treatments. The percentage data were subjected to arc sine transformation.

Results and discussion

Determination of fibre content in Nakima

An appropriate amount of fibre content in Nakima (*Tupistra nutans)* was found in treatment T_1 (16.1 %) followed by T6. T1 was found significantly different with treatments T5 and T8. However T5, T6 and T2, T3, T4, T7, T8 were found significantly at par with each other. The lowest crude fibre was obtained in T2 (18.74).

It is evident from Table no.1 that the amount of fibre content found in nakima was 16.1%. Aberoumand (2011) [1] worked on *Asparagus officinalis* and reported crude fibre to be 18.50% and the fibre content in present study was found to be lower. The reasons may be due to different instruments used at the time of extraction. Another reason might be due to prolonged drought period and scanty or erratic rainfall causing wide spread damage to plants. Similarly the soil fertility might be also one of the reasons.

Determination of Fat content in Nakima

Fat content in different treatments ranged from T1 to T8. All the treatments were found to be significantly at par at 5% level of significance. It is clearly seen from Table no. 1 that lower crude fat content (1.4%) was found in nakima as compared to the findings of Aberoumand (2014) [2] who had worked on *Asparagus officinalis.* Crude fat content was found to be (3.44 %). Similarly, the recent finding was in line with Obichi *et al.* (2015) [5] who had worked on non-conventional vegetable *Solenostemon monostachyus* and the crude fat content was found to be 2.26 %. Upon comparison to the present study, the earlier reported value was found to be higher. These differences might be due to the samples collected from different places. Some of the samples were collected from South district likewise East, West and North. It might be due to various soil types, high and low pH value, soil temperature (particularly when below approximately 50^0F) or limiting water supply. Another reason might be different harvesting time, farming and drying methods, different season, geographical origin, environmental factors, storage and handling conditions.

Determination of Ash content in Nakima

The maximum ash content was found in Nakima inflorescence in the treatment T6 (14.91%). T_7 and T8 had significant difference with T6. However, T8 was significantly at par with T1. The lowest ash content was found in T3 (2.52%). Treatments T_1, T_2, T_3, T_4, and T5 were found to be significantly different at 5% level of significance. From Table no. 1, the finding shows that the amount of ash content found in nakima was (14.91%). Aberoumand, (2011) [1] worked on *Asparagus officinalis* and reported ash content to be 10.70 %. In comparison to the earlier reported values, the findings of present study were found to be higher. The reasons might be sample collection from different districts of Sikkim where mostly cool climate remains favourable. Another was high rainfall during the inflorescence growing season and the composition of harvested inflorescence and its susceptibility to mechanical damage during shipment and storage.

Determination of crude protein content in Nakima

Crude protein content in different treatments ranged from T1 to T8. The highest crude protein content was found in treatment T2 (23.31%). Treatment T2 was found to be significantly different with treatments T7, T8, T5, T6. Hence treatments T1, T3, T4, T5, T6, and T8 were significantly at par at 5% level of significance. The lowest crude protein content was found in treatment T3 (17.24%).

It is evident from Table no. 1 that higher content of crude protein (14.45) was found in nakima as compared to the findings of Aberoumand (2011) [1] who worked on *Asparagus officinalis* and reported crude protein content to be 32.69 %.

In the present study crude protein was found maximum and the variations might be due to the different tender stages of the plant. The protein content was found to be higher because the edible part used for asparagus was tender stem but for nakima edible part was inflorescence.

Determination of reducing sugar content in Nakima

Table no. 1 shows clearly that reducing sugar content in different treatments ranged from T1 to T8. The maximum reducing sugar content was found in T3 (8.85%). T3 was found significantly at par with T4, T6, T7, T5, T2 and T8. Hence T5, T2, T8 and T1 were found significantly different at 5% level of significance. The minimum reducing sugar was recorded in T1 as 2.95%.

It is clearly shown from the Table no. 1 that the higher amount of reducing sugar content (8.85%) was found in nakima as compared to the findings of Verma *et al.* (2012) [9] who had worked on Kachnar (*Bauhinia variegata*) and found content of reducing sugar in *Bauhinia variegata* bud as 0.9% and flowers as 0.32%. Reducing sugar contents in present study were higher than earlier reported values. These differences could be due to the average radiation received and sunshine hours during the bud stage. The global radiation and sunshine hours in particular year may also have contributed in increasing photosynthesis, thereby providing the plants capacity to accumulate more sugar content. Another reason was due to collection of samples from different regions which might have been under conventional or organic cultivation.

Determination of Vitamin C (Ascorbic acid) content in Nakima

In vitamin C (Ascorbic acid) content in Nakima (*Tupistra nutans*) inflorescence, all the treatments were found to be par as the F-value in the ANOVA table was found to be non-significant.

It is evident from Table no. 1 that the lower amount of Vitamin C content (11.74 %) was found in nakima as compared to the findings of Ferrara et *al.* (2011) [4] who had worked on wild and cultivated asparagus i.e. *Asparagus acutifolius* and *Asparagus officinalis* respectively. Vitamin C

(Ascorbic acid) content was found to be 117 % and 23.05 % in the two species respectively. In the present study Vitamin C (Ascorbic acid) content was found to be lower as compared to the earlier reported study. These differences might be due to specific temperature and light conditions in the growing areas. A possible reason could be the variable open field environment in terms of rainfall or changing humidity during the fruit growing season.

Table 1: Estimation of Various Dietary Nutrients in Nakima

Treatment No.	Fibre (%)	Fat (%)	Ash (%)	Crude Protein (%)	Reducing sugar (%)	Vitamin C mg/100g
T1	16.1 (23.64)*	0.5 (3.8)	12.47	10.58 (18.96)	2.35 (2.95)	11.74
T2	10.18 (18.74)	1.0 (5.3)	10.16	14.45 (22.31)	1.14 (6.12)	9.54
T3	10.96 (19.04)	0.4 (3.43)	2.52	8.82 (17.24)	2.37 (8.85)	10.27
T4	11.16 (19.48)	0.6 (4.1)	1.74	11.50 (19.8)	1.84 (7.75)	10.27
T5	12.93 (22.18)	1.4 (6.50)	8.3	8.90 (17.45)	1.52 (7.08)	8.07
T6	14.26 (22.20)	0.8 (4.58)	14.91	9.02 (17.45)	1.31 (7.27)	8.07
T7	10.6 (18.96)	1.4 (6.50)	13.83	13.21 (21.28)	1.52 (7.10)	6.6
T8	11.9 (20.12)	0.8 (4.58)	12.79	13.02 (21.28)	1.13 (6.07)	6.6
GM	12.26 (20.545)	1.72 (4.773)	8.731	11.18 (19.44)	13.18 (6.65)	8.89
CD at 5%	0.568	1.466	0.362	0.112	0.809	3.011
SEm	0.189	0.489	0.121	0.375	0.267	1.004

*(Figures in parentheses show arcsine transformation values)

Conclusions

The present study reveals the nutritional profile of Nakima (*Tupistra nutans*). In dietary nutrients best treatment was sample T1 collected from Naga village and Singik, North Sikkim. From the above findings we can conclude on the basis of nutritional profile developed that Nakima *(Tupistra nutans)* is a good source of fibre and protein content. The nutrients present in Nakima are comparable to the popular vegetables of Sikkim like asparagus etc. Commercial utilization of Nakima in Sikkim will be beneficial for farmers of Sikkim as it may help in cost reduction of present value of this underutilized vegetable.

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